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A LECTURE
ON THE
PHYSIOLOGY OF DIGESTION,

INTRODUCTORY TO

A COURSE OF LECTURES

ON THE

INSTITUTES OF MEDICINE AND MATERIA MEDICA.

DELIVERED BEFORE THE

MEDICAL CLASS OF THE UNIVERSITY OF THE CITY OF NEW YORK,

AT THE SESSION OF 1844-5.

BY

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NEW YORK, NOVEMBER 4, 1814.

PROF. PAINE :

Dear Sir:—At a meeting of the Class of the University Medical College, held on Saturday evening last, Mr. S. S. SATCHEWELL, of North Carolina, being in the chair, and Mr. EDMUND R. DABNEY, of Tennessee, acting as Secretary, on motion, it was unanimously

Resolved—That a Committee be appointed to solicit for publication, a copy of the able and eloquent Introductory Lecture delivered by Prof. PAINE on Thursday evening last.

The undersigned having been appointed the Committee to perform this pleasing duty, allow us to add our individual wishes to those of the Class, and to hope that you will not refuse so unanimous a request.

We need not assure you how truly we are yours, &c.,

PHILIP A. AYLETT, *Alabama.*
WILLIAM J. ALEXANDER, *Virginia.*
CYRUS ARNDT, *New Jersey.*
JOHN M. K. ALFORD, *North Carolina.*
JOHN W. ALBURY, *West Indies.*
W. A. BURLEIGH, *Maine.*
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GEORGE M. TUTT, *Georgia.*
T. D. WASHBURN, *Massachusetts.*
D. E. WARREN, *Tennessee.*

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NEW YORK, NOVEMBER 8, 1844.

MESSRS. P. A. AYLETT, and others, composing a Committee of the

Medical Class of the University of New York, &c. :

Gentlemen:—In acknowledging the receipt of your very polite note, informing me of the honor done me by the Medical Class, of soliciting for publication a copy of my late Introductory Lecture, I have much pleasure in acceding to that request, and beg that you will convey to those gentlemen and accept for yourselves my sentiments of respect and esteem.

Very truly, and sincerely, yours,

MARTYN PAINE.

THE PHYSIOLOGY OF DIGESTION.

"ANIMAL and VEGETABLE physiologists institute experiments without being acquainted with the circumstances necessary to the continuance of life,—with the qualities and proper nourishment of the animal or plant on which they operate,—or with the nature and chemical constitution of its organs. These experiments are considered by them as convincing proofs, whilst they are fitted only to awaken pity."—LIEBIG.

"ALL DISCOVERIES in physics and in CHEMISTRY, all explanations of CHEMISTS, [!] must remain without fruit and useless, because even to the GREAT LEADERS IN PHYSIOLOGY, carbonic acid, ammonia, acids, and bases, are sounds without meaning, words without sense, terms of an unknown language, which awaken no thoughts, and no associations. They treat these sciences like the vulgar, who despise a foreign literature in exact proportion to their ignorance of it."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c. *ut supra*.

"A writer, who can so contradict himself, scarcely needs to be exposed by us."—CARPENTER'S *Review of Paine's "Commentaries."* See PAINE'S *"Examination of Reviews,"* pp. 12, 86.

"Just in the same way that I am willing to admit the existence of forty different simple metals, so, upon similar evidence, I am free to admit the existence of fifty different imponderable agents, if need be. Is there anything which should lead us to suppose that the imponderables are constituted by Nature on a plan that is elaborately simple, and the ponderables on one that is elaborately complex? That the former are all modifications of one primordial ether, and the latter intrinsically different bodies, more than a quarter of a hundred of which have been discovered during the present century?"

"We are thus forced to admit that rays of light, rays of heat, *tithonic* rays, phosphoric rays, and probably many other radiant forms, have an INDEPENDENT EXISTENCE, and that they can be separated, by proper processes, from each other."—DRAPER'S *Treatise on the Forces which produce the Organization of Plants*, pp. 70, 71.

DIFFERENCES of opinion on questions of great moment to mankind are apt to be strongly conveyed, and apparent error to be censured in no measured terms. This, perhaps, is often admissible, considering the obstinacy of error, and so long as it is the doctrine, and not its author, which is assailed. We may revere the names of Voltaire, of Hume, and of Gibbon, yield them a proud rank in the scale of intellect, and gratefully acknowledge the rich legacies they have left behind. But, who of us would hesitate to speak of their infidelity according to its nature and tendencies? This is even demanded by what we believe of the precepts of religion. And so of the principles of medicine, which hold as high a relation to the temporal interests of man, as do the precepts of religion to his spiritual welfare. The highest order of intellect is often devoted to the dissemination of error, and perhaps more frequently in religion and medicine than in any other of the great interests of mankind. This must be fully and firmly met, not only by evidences of the truth, but by an exposure of its perversions and corruptions.

In the discussion of my subject, (the controverted physiology of digestion,) I shall bring to your consideration the misapplication of chemistry to the processes of life; but in doing this, it will be only in the defence of truth, and not with a view of diminishing your respect for an important science. We must regard its defects abstractedly, and endeavor to eradicate such impurities as tarnish its lustre. We must still yield to it all the praise to which it is entitled by the devoted in-

dustry of its cultivators, by its elevated rank amongst the sciences, and by its usefulness to man. Indeed, as a science of general usefulness, as a source of mental improvement and of pure and elevated enjoyment, as opening to our view many of the most deeply interesting and stupendous institutions of nature, and often with that demonstration which no skepticism can resist,—I say, with all these combined advantages, it is the most important of the sciences for the general purposes of life.—And I am mostly prompted in making these remarks by the too common neglect of chemistry by the medical profession, to whom it is farther recommended by its subserviency to the healing art.

At the outset of my subject, it will be necessary to premise a few statements as to the general condition of medicine, and the auspices under which it is now cultivated.

The physiological world, as you are probably aware, has been lately divided into three schools. One of these sects virtually regards organic nature as a part only of inorganic, endowed with the same properties and governed by the same laws. It maintains, in short, that there is no real difference between a man and a stone. At the head of this school stands Liebig, the distinguished and able chemist. It is a great and powerful school, but is falling, daily, beneath the weight of its vast errors and corruptions. It is denominated the *CHEMICAL SCHOOL* of medicine. Contrasted with this is the school of *VITALISM*; and to the interests of this school, I may now say, the main efforts of my life have been devoted. Their doctrines will be taught in the lectures which I shall have the honor of laying at the foundation of your medical education; not, however, with any concealment of adverse opinions, but with an ample exhibition of their nature, and of their claims to your consideration. This school regards organic and inorganic nature as distinct in their most essential attributes; that each department is governed by properties and laws peculiar to itself. It regards the organic being as fundamentally distinct from the inorganic in its elementary constitution, in the aggregation of its molecules, in the structure of its parts, in its condition as a whole, and in every phenomenon which it evinces. It sees design in every part of the living being, eloquent even in the dry bones of a skeleton; a design peculiar to every part, whilst all concur in harmony together to the common ends of one universal design. On the contrary, also, this school discerns little of the nature of design in the constitution, or in the abstract condition of inorganic matter. It sees nothing, in respect to power, but mere *vis inertiae*; which, however, is supposed by the physical school to be capable of evolving from simple matter every variety of organization, with all its specific designs, even instinct and reason, whilst at the same time we hear from the depth of materialism, that “organic nature is the mystery of mysteries.”

Again, the vitalists, in consideration of the general facts now stated, maintain, in the language of Liebig, the great head of the school of mere physics, “the existence of a *POWER* distinct from all other powers of nature, namely, a *VITAL PRINCIPLE*,” which organizes and governs all living beings, and which is the fundamental cause of all their phenomena in health and disease. I say, in the language of Liebig, “a power distinct from all other powers of nature, namely, a *vital*

principle;" for this mere chemist, in his conflicts with living nature, concedes the existence of such a principle as at the foundation of all vital phenomena, yet in the same general manner, and on all specific questions where he has introduced its direct and exclusive agency, he as unequivocally declares that there is no such principle, and that every result of life, and disease, even thought itself, are entirely owing to chemical agencies. His whole system, as set forth in his "Organic Chemistry applied to Physiology," and in his "Animal Chemistry" applied to Pathology and Therapeutics, is a tissue of similar contradictions, of the boldest assumptions, and of stultifying doctrines. Yet, with deep mortification I say it, he has been hailed with an enthusiasm before unknown in the annals of medicine, as the only true expounder of physiology and of medical philosophy. The world, however, is fast awaking from its spellbound delusion, and the doctrines of this "reformer" will soon be mingled with the same and more original chimeras which did their part in "the dark ages of science."

Finally, the third school, or that of CHEMICO-PHYSIOLOGY, endeavor to form, as it were, a bond of union between the schools of pure vitalism, and of pure chemistry, though such an alliance be as unnatural as human brains in a block of granite. The chemico-physiologist makes a compromise with philosophy, and takes for his rule, "*in medio tutissimus ibis.*" He professes to loathe all extremes; but takes little trouble to ascertain the fact whether one doctrine or the other be fairly entitled to this appellation. He sees only the direct opposition which exists, without caring whether one "extreme," as he calls it, may not be perfectly true, whilst the other is as perfectly false. He therefore mingles the doctrines of vitalism and of chemistry; allotting to the former one half of the phenomena of life, and the other half to the latter. This is the school to which you have the greatest chance of becoming the victims; for it is apparently recommended by the conciliatory principle which I have stated in the form of its motto, and by many of the most distinguished members of our profession.

I am now prepared by these explanatory remarks, relative to the three schools of medicine, to enter upon the consideration of the philosophy of digestion; for each denomination have interpreted that philosophy according to the general doctrines of life which are peculiar to each.

Beginning with pure chemistry, we find the great leader setting forth the process of digestion in the following language, in his late work on Animal Chemistry applied to Pathology and Therapeutics. "CHYMI-FICATION," he says, "IS INDEPENDENT OF THE VITAL FORCE. It takes place in virtue of A PURELY CHEMICAL ACTION,—*exactly similar* to those processes of decomposition and transformation which are known as *putrefaction, fermentation, or decay.*" This is exactly the old doctrine of what are well denominated the "dark ages."

Now you will recollect that I have stated that it is a remarkable characteristic of the work which is assumed as the basis of the chemical philosophy of life, that it abounds with staring contradictions; and such is the fact in relation to the doctrine which I have just quoted. And how could it be otherwise, seeing that its author was con-

stantly employed about two subjects that have no relation to each other; that is to say, the philosophy of life and the philosophy of chemistry. But I will go back, for a conflicting doctrine, to the "Reformer's" treatise on Organic Chemistry applied to Physiology, published a year or two antecedently to his work on Animal Chemistry; by which we shall learn the extent of the confusion which pervades his writings, and the tardiness with which it is discerned by his medical disciples.

In that work, he says, "the equilibrium in the chemical attractions of the constituents of food is disturbed by THE VITAL PRINCIPLE. THE UNION of its ELEMENTS, so as to produce *new combinations and forms*, indicates the presence of A PECULIAR MODE OF ATTRACTION and the existence of A POWER DISTINCT FROM ALL OTHER POWERS OF NATURE, namely, THE VITAL PRINCIPLE." "If the food possessed life, not merely the chemical forces, but THIS VITALITY would offer resistance to the *vital force* of the organism it nourished."

Such, then, was the opinion of this Chemist when discoursing of life in his "Organic Chemistry applied to Physiology;" and passages of a similar import occur in his late work on "Animal Chemistry,"—ay, and standing in connection with his equally fundamental, and hostile doctrine, which refers every living process and result to the merest chemical agencies.

The work, however, on Animal Chemistry is more of a distillation from the Laboratory than its predecessor; and as many of the most eminent physiologists in Europe, who were inclined to mingle chemistry with vitalism, were nauseated by the dose which was last administered, Liebig came out in his lectures for the session of the present year, (1844) with the following placebo for the vitalists and the chemico-physiologists. It is of some extent; but, as it embraces exactly the doctrines which I have been always employed in teaching, and which are still fundamental in my lectures, I shall quote it, at length; so that, should there be any present who may have become imbued with the popular superstition in regard to Liebig's notions in Physiology, they may rest assured that my lectures will have for their basis what will be allowed by their favorite Liebig to be the only true foundation of the Institutes of Medicine. Thus, then, the German Chemist, when, only six months ago, he was lecturing, like myself, on the functions of life.

"After the EXTINCTION* of the vital Principle," he says, "in organic atoms, they maintain their form and properties, the state into which they have been brought in living organisms, *only* by reason of their *inherent inertia*. It is a great and comprehensive law of matter that its particles possess no self-acting, no inherent power of originating motion, when at rest. Motion must be imparted by some external cause: and, in like manner, motion once imparted to a body can only be arrested by external resistance." So much for simple matter. Now for matter in an organic state. "The constituents of vegetable and animal substances," he goes on, "having been formed under the guidance and power of *the vital principle*, it is *this principle* which determines the direction of their molecular attraction. THE VITAL PRINCIPLE

* See my "Examination of Reviews," p. 26—28.

PLE, therefore, must be A MOTIVE POWER, CAPABLE OF IMPARTING MOTION TO ATOMS AT REST, and of *opposing resistance* to OTHER FORCES producing motion, such as the CHEMICAL FORCE, heat and electricity. We are able to reliquify and redissolve albumen after it has been coagulated by heat; but, the vital principle ALONE is capable of restoring the original order and manner of the molecular arrangement in the smallest particles of albumen. Coagulated albumen is again converted into its original form; it is transformed into flesh and blood in the animal organism.

"In the formation of vegetable and animal substances the vital principle opposes, as a FORCE OF RESISTANCE, the action of the OTHER FORCES,—cohesive attraction, heat, and ELECTRICITY,*—forces which render the aggregation of atoms into combinations of the *highest* order IMPOSSIBLE, *except in living organisms*.

† "Hence it is, that when those complex combinations which constitute organic substances are withdrawn from the influence of the VITAL FORCE,—when this no longer is opposed to the action of the OTHER disturbing forces, great alterations immediately ensue in THEIR PROPERTIES, and IN THE ARRANGEMENT of their constituents. The slightest chemical action, the mere contact of atmospheric air, suffices to cause a transposition in their atoms, and to produce new arrangements; in one word, to excite DECOMPOSITION. Those remarkable phenomena then take place which are designated by the terms *fermentation, putrefaction, and decay*. THESE are the processes of DECOMPOSITION, and their ultimate results are to reconvert the elements of organic bodies into that state in which they exist *before they participate in the processes of life*." —*London Lancet, May 18, 1844.*

Now, gentlemen, you are no doubt astonished, and well you may be, to hear such language, and the latest, too, that he has spoken, from the chief of the school who, IN REALITY, admit of nothing but pure chemistry in their system of physiology. The language which I have just quoted from Liebig, should place him amongst the unqualified vitalists. It conveys the doctrines which lie at the foundation of my Medical and Physiological Commentaries, and which are opposed, *in toto*, to the hallucinations of Chemistry. And yet I have already made other quotations from the same writer, and on the same subjects, which you will have observed contradict, in the broadest and most absolute manner his doctrines as to the vital principle. The latter seem to be thrown out "as springes to catch woodcocks," or as others have it, as "a tub to the whale."

Such, then, are examples of the medley of contradictions in great fun-

* Heat, light, and electricity, are often absurdly supposed to constitute *forces* in their relation to living beings. In that relation they are merely *vital stimuli*, calling into action the properties of life. These properties are the only forces which have any connection with the phenomena evinced by animals or plants. As to the doctrine of *capillary attraction*, whether applied to the capillary circulation of plants or animals, it is the very worst of all the physical views of life; since it strikes a fatal blow at all organic processes and results, and at all the physiological and pathological doctrines which are founded upon them. The doctrine, on the other hand, is contradicted by all the phenomena and results which appertain to organic life; since they are all dependent on special modes of vital action carried on by the capillary system.

damental principles, with which the writings of this very extraordinary and successful pretender in medicine, abound. On the same page we meet a purely chemical and a purely vital philosophy of digestion; and equally so of other important organic processes. Each is laid down without qualification, and with the *dictum* of a master who is conscious that the preponderance he gives to the purely chemical philosophy of life will establish his Empire in that philosophy with an age more prone than ever to the doctrines of materialism. On the very subject of a *vital principle* itself he is as flatly contradictory as on the cause of digestion; for at one moment he avows the existence of such a principle, "distinct from all other powers of nature," and calls it "the vital principle," which he says governs all the processes of living beings, and at the next moment he avers that "IN THE ANIMAL BODY WE RECOGNIZE, AS THE ULTIMATE CAUSE OF ALL FORCE, ONLY ONE CAUSE, THE CHEMICAL ACTION *which the elements of the food and the oxygen of the air mutually exercise on each other.* The only known ultimate cause of *vital force, either in animals or in plants, is a chemical process.*" Thus, also, he increases the medley of contradictions in relation to digestion, by making that process to depend on a purely chemical action, and to evolve that vital principle which he had already avowed is the only power concerned in chymification.

But be not deceived; for, however this "reformer" may beguile you with words, and seem to persuade rather than to rule, remember that, at most, he does but invalidate his own edicts by countermands, and that in the end he tells you that those apparently adverse decrees are, in their absolute import, one and the same; that they are consistent laws delivered from the laboratory, though apparently in conflict on account of the opposing forces, the attraction and repulsion, which preside in the chemistry of nature; that, however, in reality, there is no difference whatever in the seemingly two great principles which lie at the foundation, which are one and identical, since "THE MYSTERIOUS VITAL PRINCIPLE CAN BE REPLACED BY THE CHEMICAL FORCES,"* and since, also, "THE VITAL FORCE UNITES IN ITS MANIFESTATIONS ALL THE PECULIARITIES OF THE CHEMICAL FORCES, AND OF THE NOT LESS WONDERFUL CAUSE WHICH WE REGARD AS THE ULTIMATE ORIGIN OF ELECTRICAL PHENOMENA."†!!

I dwell upon these absurdities, that you may the better realize the shallowness of that pretended philosophy which has so lately swept, like a hurricane, over the intellectual world; that you may see, in this system of contradictions, the equal fallacy of that school who endeavor, with greater sincerity, to mingle the conflicting principles, and that you may the better cultivate and enjoy the simple and consistent philosophy which nature teaches. Nor will I yet leave that stupendous system of assumption and contradiction which was so lately hailed by physiologists as the harbinger of a total revolution in medical science, ay, in the very practice of medicine, without showing you the depth of the materialism in which it was submerged. I say nothing now of the avowed infidelity to which it has led. Examples of that disregard of instinctive faith I have al-

* LIEBIG'S *Organic Chemistry applied to Physiology, &c.*

† LIEBIG'S *Animal Chemistry.*

ready placed in their proper connection with my present subject.* But, I will merely quote from Liebig's revolutionary work a doctrine of the chemical school, from which, if I mistake not your ambition as intellectual and immortal beings, the very impulse of nature will turn you with a loathing aversion. You will see from it, also, how utterly degraded to the rank of the merest matter is every thing relating to organic life; even man himself. Thus, then, our author in behalf of the school of chemistry. "Physiology," he says, "has sufficiently decisive grounds for the opinion, that *every motion, every manifestation of force*, is the RESULT of a transformation of the structure or of its substance; that every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids; that every thought, every sensation, is accompanied by a change in the composition of the substance of the brain."—"Every manifestation of force is the RESULT of a transformation of the structure or of its substance."

Many organic chemists, however, are disposed to admit the existence of a spiritual part, and they should therefore recollect that the existence of a principle of life is substantiated by far more numerous facts than the spirituality of mind, which they are so ready to concede when inviting your attention to their physical doctrines of life. They should be as ready to yield to one series of facts as to the other, and especially to the more cogent series when the minor is *obtruded* upon your belief.

Let us now observe the hostile attitude of some of the important doctrines which I have quoted from Liebig, by repeating them in direct connection, that we may the more distinctly realize the absurdities which come to us from the laboratory of the chemist, when its ambitious aim is turned upon physiology. Examples of similar conflicting views abound in the writings of "the reformer."—Thus:—

"MY OBJECT has been, in the present work, to direct attention to the points of intersection of *chemistry with physiology*, and to point out those parts in which the sciences become, as it were, *mixed up together*. It contains a collection of problems, such as *chemistry* at present requires to be resolved, and a number of conclusions drawn *according to the rules* of that science. These questions and problems will be resolved; and we cannot doubt that we shall have in that case A NEW PHYSIOLOGY AND A RATIONAL PATHOLOGY."—LIEBIG'S *Animal Chemistry*.

"In the *animal body* we recognise as the ultimate cause of all force only one cause, the CHEMICAL ACTION which the elements of the food and the oxygen of the air mutually exercise on each other. The only known ultimate cause of vital force, either in animals or in plants, is a CHEMICAL PROCESS. If this be prevented, THE PHENOMENA OF LIFE DO NOT MANI-

"A RATIONAL physiology cannot be founded on mere re-actions, and the living body cannot be viewed AS A CHEMICAL LABORATORY."—LIEBIG'S *Animal Chemistry*.

"The study of the USES of the functions of different organs, and of their MUTUAL CONNECTION in the animal body, was formerly the chief object in physiological researches; but lately THIS STUDY has fallen into the background."—*Ibid.* [See motto.]

"In the *animal organism*, as well as in THE SEED OF A PLANT, we recognize A CERTAIN REMARKABLE FORCE, THE SOURCE OF GROWTH, or increase in the mass, and of reproduction, or of supply of the matter consumed; A FORCE IN A STATE OF REST.* By the action of external influ-

* See my "Examination of Reviews," p. 7—24.

* See my "Medical and Physiological Commentaries," vol. 2, p. 122—140. Also the *Essay on the Vital Powers*.

FEST THEMSELVES. If the chemical action be impeded, the vital phenomena must take *new forms*." "ALL VITAL ACTIVITY ARISES from the mutual action of the oxygen of the atmosphere and the elements of the food."—LIEBIG'S *Animal Chemistry*.

"Physiology has sufficiently decisive grounds for the opinion, that EVERY MOTION, EVERY MANIFESTATION OF FORCE, IS THE RESULT OF A TRANSFORMATION OF THE STRUCTURE OR OF ITS SUBSTANCE; that every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids; that every thought, every sensation, is accompanied by a change in the composition of the substance of the brain"!—LIEBIG'S *Animal Chemistry*.

"In the processes of NUTRITION and REPRODUCTION, we perceive the passage of matter from the state of motion to that of rest, (static equilibrium.) Under the influence of the nervous system, this matter enters again into a state of motion. The ultimate causes of these different conditions of the vital force are CHEMICAL FORCES."

"THE CAUSE of the state of MOTION is to be found in a series of changes which the food undergoes in the organism, and these are the RESULTS OF PROCESSES OF DECOMPOSITION, to which either the food itself, or the STRUCTURES formed from it, or parts of organs, are subjected."—LIEBIG'S *Animal Chemistry*. [See 2d and 3d paragraphs, page 13, left hand column, and right hand column, page 11.]

"THE POWER to effect TRANSFORMATIONS does not belong to the vital principle. Each transformation is owing to a disturbance in the attraction of the elements of a compound, and is, consequently, a PURELY CHEMICAL PROCESS."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.—[See, also 3d paragraph, page 13, and 3d paragraph, page 14, right hand column, and others equally contradictory.]

ences, by impregnation, by the presence of air and moisture, the condition of STATIC EQUILIBRIUM of this force is disturbed. ENTERING INTO A STATE OF MOTION OR ACTIVITY, it exhibits itself in the PRODUCTION of a series of forms, which, although occasionally bounded by right lines, are yet widely distinct from geometrical forms, such as we observe in crystallized minerals. This force is called THE VITAL FORCE, *vis vita*, or VITALITY."—LIEBIG'S *Animal Chemistry*.—[See my *Essays on Vitality*, &c. p. 13—18.]

"THE VITAL PRINCIPLE must be a MOTIVE POWER, CAPABLE OF IMPARTING MOTION TO ATOMS AT REST, and of OPPOSING RESISTANCE TO OTHER FORCES producing motion, such as the CHEMICAL FORCE, heat and ELECTRICITY."—LIEBIG'S *Lectures for 1844*.

"In the animal organism we are acquainted with ONLY ONE CAUSE OF MOTION; and this is the SAME CAUSE which determines the growth of living tissues, and gives them the power of resistance to external agencies. IT IS THE VITAL FORCE."

"There is NOTHING to prevent us from considering the VITAL FORCE as a PECULIAR property, which is possessed by certain material bodies, and becomes sensible when their elementary particles are combined in a certain arrangement or form. This supposition takes from the *vital phenomena* nothing of their wonderful peculiarity. It may, therefore, be considered as a RESTING POINT from which an investigation into these phenomena, and the LAWS which regulate them, may be commenced; exactly as we consider the properties and laws of LIGHT to be dependent on a certain *luminiferous matter* or other, which has no farther connection with the laws ascertained by investigation."—LIEBIG'S *Animal Chemistry*.

"Our notion of life involves something more than mere reproduction, namely, the idea of AN ACTIVE POWER exercised by virtue of a definite form, and production and generation in a definite form. The production of organs, and their power not only to produce their component parts from the food presented to them, but to GENERATE THEMSELVES in their *original form* and with all their properties, are characters BELONGING EXCLUSIVELY TO ORGANIC LIFE, and constitute a form of reproduction INDEPENDENT OF CHEMICAL POWERS. The chemical forces are subject to THE INVISIBLE CAUSE BY WHICH THIS FORM IS

"Every thing in the animal organism, to which the name of MOTION can be applied, proceeds from the NERVOUS apparatus. The phenomena of MOTION IN VEGETABLES, the circulation of the sap, for example, observed in many of the characæ, and the closing of flowers and leaves, depend on physical and mechanical causes. HEAT and LIGHT are the remote CAUSES of MOTION in VEGETABLES; but in ANIMALS we recognize in the *nervous apparatus* A SOURCE OF POWER, capable of renewing itself at every moment of their existence."—LIEBIG'S *Animal Chemistry*.—[See, also, last paragraph, page 9, right hand column.]

Nevertheless, although—

"Plants require LIGHT, and, indeed, sun light, it is not necessary that the direct rays of the sun reach them. Their FUNCTIONS certainly proceed with greater intensity and rapidity in sunshine, than in the diffused light of day; but it merely ACCELERATES in a greater degree THE ACTION ALREADY EXISTING."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"THE VITAL FORCE UNITES in its manifestations ALL THE PECULIARITIES OF CHEMICAL FORCES, and of the not less wonderful CAUSE which we regard as the ultimate origin of ELECTRICAL phenomena." [See, also, first paragraph, page 10, right hand column, and second paragraph, page 7, and note.]—LIEBIG'S *Animal Chemistry*.

"The mysterious VITAL PRINCIPLE can be REPLACED by the CHEMICAL FORCES."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"While the ASSIMILATION of food in VEGETABLES and the WHOLE PROCESS OF

PRODUCED. OF THE EXISTENCE OF THIS CAUSE ITSELF we are made aware ONLY by the phenomena which it PRODUCES. ITS LAWS must be investigated just as we investigate THOSE of the OTHER POWERS which effect motion and changes in matter."

"THE VITAL PRINCIPLE is ONLY known to us through the peculiar form of ITS INSTRUMENTS; that is, through the organs in WHICH IT RESIDES. Hence, whatever kind of energy a substance may possess, if it is amorphous and destitute of ORGANS from which the IMPULSE, MOTION, or change, proceeds, IT DOES NOT LIVE. Its ENERGY depends, in THIS CASE, on a CHEMICAL ACTION. LIGHT, HEAT, electricity, or other influences [justly considered here by Liebig as vital stimuli and not forces] may increase, diminish, or arrest THIS ACTION; but they ARE NOT ITS EFFICIENT CAUSE." "THE VITAL PRINCIPLE OPPOSES to the continual action of the atmosphere, moisture, and temperature, upon the organism, A RESISTANCE which is, in a certain degree, invincible. It is by the constant neutralization and renewal of these external influences that life and motion are maintained."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"IN WHAT FORM OR IN WHAT MANNER THE VITAL FORCE PRODUCES MECHANICAL EFFECTS IN THE ANIMAL BODY is ALTOGETHER UNKNOWN, AND IS AS LITTLE TO BE ASCERTAINED BY EXPERIMENT AS THE CONNECTION OF CHEMICAL ACTION WITH THE PHENOMENA OF MOTION, which we can produce with the galvanic battery. We know not how a certain invisible something, heat, gives to certain bodies the power of exerting an enormous pressure on surrounding objects. We know not even how this something itself is produced when we burn wood or coals.

"So it is with THE VITAL FORCE, and with THE PHENOMENA exhibited by living bodies. THE CAUSE of these PHENOMENA is NOT CHEMICAL force; IT IS NOT ELECTRICITY, nor magnetism. It is a PECULIAR FORCE, because it exhibits manifestations which are formed by NO OTHER KNOWN FORCE."

"In regard to the NATURE and ESSENCE of the vital force, we can hardly deceive ourselves, when we reflect, that it behaves, in all its manifestations, exactly like other natural forces; that it is devoid of consciousness or of volition, and is subject to the action of a BLISTER."—LIEBIG'S *Animal Chemistry*.

"An abnormal production of certain component parts of plants presupposes A

THEIR FORMATION, ARE DEPENDENT ON CERTAIN EXTERNAL INFLUENCES *which produce motion, the development of the animal organism is, to a certain extent, independent of those external influences, just because the animal body can produce within itself that source of motion which is indispensable to the vital process.*"—LIEBIG'S *Animal Chemistry*.

"Neither the emission of carbonic acid nor the absorption of oxygen (by plants) has any connection with the process of ASSIMILATION; nor have they the slightest relation to each other. The one is purely a mechanical, the other a purely chemical process. A COTTON WICK, inclosed in a lamp, which contains a liquid saturated with carbonic acid, acts *exactly* in the same manner as a living plant in the night."—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*

At night, a true CHEMICAL process COMMENCES, [though EVERY process is either purely mechanical or purely chemical, by night or by day, according to the last quotation] in consequence of the action of the oxygen of the air upon the substances composing the leaves, blossoms, and fruit. This process is not at all connected with the life of the vegetable organism, because it goes on in the DEAD plant EXACTLY as in a living one."!

Nevertheless,—

"What value can be attached to experiments, in which all those matters which a plant REQUIRES in the process of ASSIMILATION, besides its MERE NUTRIMENT, have been EXCLUDED WITH THE GREATEST CARE? Can the LAWS OF LIFE be investigated in an organized being which is diseased or DYING?"—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*—Or, can those laws be investigated in "a Cotton wick, inclosed in a lamp"?

"Analogy, that fertile source of error, has unfortunately led to the very UNAPT COMPARISON of the VITAL functions of PLANTS with those of ANIMALS."—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*—[See, also, right hand column above.]

Plants, when properly placed in glass vessels containing distilled water, will, by means of their ROOTS, DECOMPOSE the glass, and absorb its silex and alkali, and assimilate those substances to themselves, and in despite of any chemical affinities; yet,

POWER AND CAPABILITY OF ASSIMILATION, to which the most powerful CHEMICAL ACTION CANNOT BE COMPARED. The best idea of it may be formed, by considering that it surpasses in power the strongest galvanic battery, with which we are not able to separate the oxygen from carbonic acid, as is done by the *leaves of plants*," "and without the direct solar rays."

"All that we can do is to supply those substances which are adapted for ASSIMILATION BY THE POWER *already present* in the organs of the plant."—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*—See, also, third quotation in this column, page 9.

"The living part of a plant acquires the whole force and direction of its VITAL ENERGY from the absence of all conductors of force. By *this means* the leaf is enabled to overcome the strongest chemical attractions, to DECOMPOSE CARBONIC ACID, and to ASSIMILATE the ELEMENTS of its nourishment."—LIEBIG'S *Animal Chemistry*.

"In vegetable physiology, a leaf is regarded in every case *merely as a leaf*, notwithstanding that leaves generating oil of turpentine or oil of lemons, *must possess a different nature* from those in which oxalic acid is formed. VITALITY, in its *peculiar operations*, MAKES USE of a SPECIAL apparatus for *each* function of an organ. Vegetable physiologists, in the study of their science, have not directed their attention to *that part* of it (the laws of vitality) which is *most worthy* of investigation."—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*

"In the living plant, the INTENSITY of the VITAL FORCE far exceeds that of the CHEMICAL ACTION of oxygen. We know, with the UTMOST CERTAINTY, that, by the influence of the VITAL FORCE, OXYGEN is separated FROM ELEMENTS to which it has the strongest affinity; and that it is given out in the gaseous form, without exerting the slightest action on the juices of the plant."

"THE ANIMAL ORGANISM IS A HIGHER KIND OF VEGETABLE."

"ASSIMILATION, or the process of FORMATION and GROWTH, goes on in the SAME WAY in ANIMALS and in VEGETABLES. In both the SAME CAUSE determines the increase of mass. This constitutes the TRUE vegetative life."—LIEBIG'S *Animal Chemistry*.

"The CONSTITUENTS of VEGETABLE and animal substances are formed under the guidance and power of THE VITAL

"All substances in solution in a SOIL are absorbed by the roots of plants, EXACTLY as a sponge imbibes a liquid, and all that it contains, WITHOUT SELECTION," and "their ASSIMILATION is a PURELY CHEMICAL PROCESS."—LIEBIG'S *Organic Chemistry applied*, &c.,

"The most decisive experiments of physiologists have shown that the process of CHYMIFICATION is independent of the vital force; that it takes place in virtue of a PURELY CHEMICAL action, EXACTLY SIMILAR to those processes of DECOMPOSITION or transformation which are known as PUTREFACTION, FERMENTATION, or DECAY."—LIEBIG'S *Animal Chemistry*.

"Those remarkable phenomena, FERMENTATION, PUTREFACTION, and DECAY, are the PROCESSES of DECOMPOSITION, and their ultimate results are to RECONVERT the elements of organic bodies into that state in which they exist before they participate in the processes of life."—LIEBIG'S *Lectures for 1844*.

"In the action of the gastric juice on the food, NO OTHER element takes a share except the OXYGEN of the atmosphere." "This air by means of the saliva, reaches the stomach with the food, and there its oxygen enters into combination."—LIEBIG'S *Animal Chemistry*.

"THE POWER of elements to unite together, and to form peculiar compounds which are generated in animals and vegetables, is CHEMICAL AFFINITY."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c [See, also, as to elements, the 2nd, 4th, and 6th paragraphs, page 12, and 3rd paragraph, page 9, and the 1st, 2d, 3d, and 4th paragraphs, page 14, right hand column; and other places.]

"We should not permit ourselves to be withheld, by the idea of a VITAL PRINCIPLE, from considering in a CHEMICAL POINT OF VIEW, the process of TRANSFORMATION OF THE FOOD, and its ASSIMILATION by the VARIOUS ORGANS. This is the more necessary, as the views, hitherto held, have produced no results, and are quite incapable of useful application."—LIEBIG'S *Organic Chemistry applied* &c.—[See last paragraph, page 10, right hand column, and other contradictory quotations in same column.]

PRINCIPLE, which determines the direction of their molecular attraction." "In the formation of vegetable and animal substances, THE VITAL PRINCIPLE opposes, as a FORCE OF RESISTANCE, the action of the OTHER FORCES," &c.—LIEBIG'S *Lectures for 1844*.

"THE EQUILIBRIUM in the chemical attractions of the constituents of food is disturbed BY THE VITAL PRINCIPLE"; and "THE UNION of its ELEMENTS, so as to produce new combinations and forms, indicates a peculiar mode of attraction, and the existence of a POWER DISTINCT FROM ALL OTHER POWERS of NATURE, namely, the VITAL PRINCIPLE."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"THE VITAL FORCE CAUSES A DECOMPOSITION of the constituents of food, and destroys the force of attraction which is continually exerted between their molecules. It alters the direction of the CHEMICAL FORCES in such wise, that the ELEMENTS of the constituents of the food arrange themselves in another form, and combine to produce new compounds. It FORCES the new compounds to assume forms ALTOGETHER DIFFERENT from those which are the result of the attraction of cohesion when acting freely, that is, without resistance."

"THE VITAL FORCE appears as a MOVING FORCE or cause of motion, when it OVERCOMES the CHEMICAL FORCES, cohesion and AFFINITY, which act between the constituents of food, and when it CHANGES the position or place in which their ELEMENTS occur. THE VITAL FORCE is manifested as A CAUSE OF MOTION in OVERCOMING THE CHEMICAL ATTRACTION of the constituents of food, and is, farther, THE CAUSE which COMPELS them to combine in a new arrangement, and to assume new forms."—LIEBIG'S *Animal Chemistry*.

"When a chemical compound of simple constitution is introduced into the stomach, its CHEMICAL ACTION is, of course, OPPOSED BY THE VITAL PRINCIPLE. The results produced depend upon the strength of their respective actions. Either an equilibrium of BOTH POWERS is attained, a change being effected without the destruction of the vital principle; in which case a MEDICINAL EFFECT is occasioned. Or, the acting body YIELDS to THE SUPERIOR FORCE of VITALITY, that is, IT IS DIGESTED. Or, lastly, the CHEMICAL ACTION obtains the ascendancy and ACTS AS A POISON."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"In the natural state of the digestive process, the food *only undergoes a change in its state of cohesion*, becoming fluid without any other change of properties."—LIEBIG'S *Animal Chemistry*.

Although—"the process of CHYMIFICATION IS INDEPENDENT of the *vital force*, and takes place in virtue of a *purely chemical action*, EXACTLY similar to those processes of Decomposition which are known as PUTREFACTION, FERMENTATION, or DECAY";—nevertheless, "INORGANIC compounds DIFFER from ORGANIC in as great a degree as in their *simplicity of constitution*."—LIEBIG'S *Animal Chemistry*, and *Organic Chemistry*.—See next quotation, this column, and 1st paragraph page 22.

"By CHEMICAL AGENCY we can produce the CONSTITUENTS of muscular fibre, skin, and hair"! "We are able to form, in our laboratories, formic acid, urea, &c. We see, therefore, that this MYSTERIOUS VITAL PRINCIPLE CAN BE REPLACED BY THE CHEMICAL FORCES"!—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.—[See page 22d, first paragraph.]

"The INFLUENCE of poisons and of remedial agents on the living animal body evidently shows that the CHEMICAL decompositions and combinations in the body, WHICH MANIFEST THEMSELVES IN THE PHENOMENA OF VITALITY, may be increased in intensity by CHEMICAL FORCES of an analogous character, and retarded or PUT AN END TO by THOSE of opposite character; and that we are enabled to exercise an influence on every part of an organ by means of substances possessing a well defined CHEMICAL ACTION."—LIEBIG'S *Animal Chemistry*.

"With respect to the ACTION of quinine, or the alkaloids of opium, &c., physiologists and pathologists entertain no doubt that it is exerted chiefly on the brain and nerves. If we reflect that this action is exerted by substances which are material, tangible and ponderable; that they disappear in the organism; that a double dose acts more powerfully than a single one; that, after a time, a fresh dose must be given if we wish to produce the action a second time; all these considerations, viewed chemically, [!] permit only one form of explanation; the supposition, namely, that these compounds, by means of their elements, take a share in

"The individual organs, such as the STOMACH, cause all the organic substances conveyed to them, which are capable of transformation, to assume NEW FORMS. The STOMACH compels the ELEMENTS of these substances to unite into a COMPOUND fitted for the formation of the blood."—LIEBIG'S *Organic Chemistry*, &c.

"The FIRST substance capable of affording nutriment to animals is the LAST product of the CREATIVE ENERGY of vegetables."—LIEBIG'S *Animal Chemistry*.

"The special characters of food, that is of substances fitted for assimilation, are ABSENCE of ACTIVE CHEMICAL PROPERTIES, and the capability of yielding to transformations."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"The CONSTITUENTS of VEGETABLE and ANIMAL substances HAVING BEEN FORMED under THE GUIDANCE AND POWER of the VITAL PRINCIPLE, it is *this principle* which determines the direction of their molecular attraction."—"The *vital principle* ALONE is capable of restoring the original order and manner of the molecular arrangement in the smallest particles of albumen."—LIEBIG'S *Lectures* for 1844.

"From the theory of disease developed in the preceding pages, it follows, obviously, that a *diseased* condition once established, in any part of the body, CANNOT be made to disappear by the CHEMICAL ACTION of a remedy."—LIEBIG'S *Animal Chemistry*.

"THE VITAL FORCE IS SUBJECT TO THE ACTION OF A BLISTER."—*Ibid*.

the FORMATION of *new* or the TRANSFORMATION of EXISTING BRAIN AND NERVOUS MATTER"!—LIEBIG'S *Animal Chemistry*.

"It is impossible to mistake the *modus operandi* of putrefied sausages, or muscle, urine, cheese, cerebral substance, and other matters, in a state of *putrefaction*." "It is obvious that they COMMUNICATE THEIR OWN STATE OF PUTREFACTION TO THE SOUND BLOOD, from which they were produced, *exactly in the same manner as gluten* in a state of decay or putrefaction *causes a similar transformation in a solution of sugar*."!

"The MODE OF ACTION of a *morbid virus* exhibits such a STRONG SIMILARITY TO THE ACTION OF YEAST upon liquids containing sugar and gluten, that the two processes have been long since *compared* to one another, although merely for the purpose of *illustration*. [They have often been represented as *identical*.] But, when the phenomena attending the action of each respectively are considered more closely, it will in REALITY be seen that their influence DEPENDS UPON THE SAME CAUSE." "Ordinary yeast and the *virus of human smallpox*, effect a violent tumultuous transformation, the former in vegetable juices, the latter *in the blood*"! "The action of the *virus of cowpox* is analogous to that of *low yeast* ['! It communicates *its own state of decomposition* to a MATTER in the blood, and from a SECOND MATTER is itself regenerated"! "The *susceptibility* of infection by the virus of human smallpox MUST CEASE *after vaccination*, FOR THE SUBSTANCE to the presence of which this susceptibility is owing HAS BEEN REMOVED from the body by a peculiar process of DECOMPOSITION artificially excited"! "COLD MEAT is always in a state of decomposition. It is possible that THIS STATE may be communicated TO THE SYSTEM of a FEEBLE individual, and may be one of the SOURCES OF CONSUMPTION"!—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

"IN ALL CHRONIC DISEASES, DEATH IS PRODUCED BY THE SAME CAUSE, NAMELY, THE CHEMICAL ACTION OF THE ATMOSPHERE."—LIEBIG'S *Animal Chemistry*.

"The VIVIFYING agency of the BLOOD must ever continue to be the most important condition in the *restoration* of a disturbed EQUILIBRIUM, and the blood must, therefore, be considered and constantly kept in view, as the ultimate and MOST POWERFUL CAUSE OF LASTING VITAL RESISTANCE, as well in the DISEASED as in the UNAFFECTED parts of the body."—LIEBIG'S *Animal Chemistry*.

Nevertheless,—

"No other component part of the organism *can be compared* to the BLOOD, in respect of the FEEBLE RESISTANCE which it offers to exterior influences."—"The chemical force and the vital principle hold each other in such perfect EQUILIBRIUM, that every disturbance, *however trifling*, or from WHATEVER CAUSE it may proceed, EFFECTS A CHANGE IN THE BLOOD."—LIEBIG'S *Organic Chemistry applied*, &c.—

"We can have no very high idea of experiments made by gentlemen, (*chemists*, with reference to digestion,) who, for want of anatomical knowledge, have not been able to pursue their reasoning even beyond the simple experiment itself."—JOHN HUNTER'S *Observations on Digestion*.

*** The quotations from "Liebig's Organic Chemistry applied to Physiology," are derived from Mr. Playfair's edition, London, 1840; those from "Liebig's Animal Chemistry," are taken from Professor Gregory's edition, reprinted, New York, 1842.

It only remains now to say of the foregoing contradictions (hitherto unnoticed,) that, whenever and wherever they, or their resemblances, occur in any department of science, we may of course rely upon it that the writer is in pursuit of any thing but truth, or is most inexcusably ignorant of his subject. In medicine, too, we may readily suspect

that every thing is spurious which comes to us upon the wings of the imagination, or where we meet with tropes and metaphors instead of crucibles and acids, or with harmonious words instead of obstinate facts and hard thinking.

It follows, therefore, from what I have stated of the incongruities of the chemical school on the philosophy of digestion, as well as of all other functions of life, that I need not say much of the groundless nature of that mingled system of contrarieties by which the chemico-physiologists interpret the same functions. Their doctrine of digestion is thus laid down by the distinguished chemist, Dr. Prout; for you should understand that chemists, not physiologists and physicians, not the students of organic nature, are the great leaders in the medical schools of pure chemistry and of chemico-physiology. "First," says Dr. Prout, "the stomach has the power of dissolving alimentary substances, or, at least, of bringing them to a semi-fluid state. This operation seems to be altogether chemical.

"2d. The stomach has, within certain limits, the power of changing into one another the simple alimentary principles;" and "this part of the operation of the stomach appears, like the reducing process, to be chemical; but not so easy of accomplishment. It may be termed the converting operation of the stomach.

"3d. The stomach must have, within certain limits, the power of *organizing and vitalizing* the different alimentary substances." "It is impossible," he says, "to imagine that this organizing agency of the stomach can be chemical. The agency is *vital*, and its nature completely unknown."

Such, then, is the doctrine of digestion as entertained by the chemico-physiologists. But, from what we have already seen of the absolute contradictions which abound in the writings of those who attempt the application of pure chemistry to the functions and results of organic life, we may expect that the chemico-physiologist will be equally inconsistent when he applies himself, at one time, to the phenomena of living beings, and, at another, reasons from the results of the laboratory to those phenomena. Accordingly, we find within a few pages of the foregoing doctrine of the chemico-physiologist, that he broadly affirms that "there is *no relation whatever* between the *mechanical* arrangements and the chemical properties to which they administer." "There is *no reason* why the chemical changes of organization should result from the mechanical arrangements by which they are accomplished, neither is there the *slightest* reason, why the mechanical arrangements in the formation of organized beings should lead to the chemical changes of which they are the instruments."

Here, then, in a single sentence, are not only the strangest contradictions, but a full admission that there is not the "*slightest reason*" for the application of chemistry to any process, function, or result of living beings.

Nor is this all. For the chemico-physiologist, the same eminent chemist whom I have just quoted, goes on to say, that "with the living, the animative properties of organic bodies, chemistry has not the *smallest alliance*; and probably will never, in any degree, elucidate those properties. The phenomena of life are not," he says, "*even remotely*

analogous to anything we know in chemistry as exhibited among inorganic agents." And, as if to complete the overthrow of the chemical part of the philosophy of digestion, the same reasoner observes that, "The means by which the peculiarities of composition and structure are produced, which is so remarkable in all organic substances, like the *results* themselves, are *quite peculiar*, and bear little or *no resemblance* to any artificial process of chemistry;" that "nature will not permit the chemist to officiate as her journeyman in the most trifling degree." So, also, Dr. Roget, alike distinguished in the school of chemico-physiology. "Vital chemistry," he says, "is too subtle a power for human science to detect, or for human art to imitate." And to the same effect may be quoted Dr. Carpenter, one of the foremost in the school of pure chemistry. "The agency of *VITALITY*," says this reasoner, who generally ridicules the term and all that is supposed to relate to it, "*the agency of vitality*," he says, "as Dr. Prout justly remarks, does not change the properties of the elements, but simply *combines the elements* in modes *which we cannot imitate*." And thus might I go on with one after another, till I should have exhausted the whole that have attempted to confound the science of life with the science of chemistry, and show you by their own statements that there is not the slightest intelligible connection between them. Indeed, I have already, on a former occasion, pointed out this universal admission.

The ground of chemistry being thus virtually abandoned to the vitalist, it would seem superfluous to pursue an adversary who is always upon the retreat. But, as he flies, he is for ever shooting from behind, and his Parthian weapons fall thickly and heavily upon the vast multitude. He must therefore be subdued into a practical acquiescence with those consistent principles of nature which exact his consent, but not his compliance.

The subject of digestion supplies one of the numerous opportunities of pushing the chemico-physiologist upon open ground, and of exhibiting truth in its unadulterated purity. It is here, too, especially, that chemistry has reared its batteries, and whence it sends forth its artillery into the various dominions of the organic world. Yet it is here, that vitality is exemplified in its most impressive and astonishing aspects, and where unequivocal demonstrations abound that fluids, as well as solids, are endowed with the principle of vital operations.—It is here, especially, that nature has illustrated her distinction between the animate and inanimate world, and established her chain of connection. It is here, in the incipient change of dead into living matter, that we witness a full display of those powers which operate in the most elaborate organization, and an equal exclusion of the forces which appertain to dead matter. It is here the line of separation begins abruptly; but where analogies are preserved in the conversion of dead into living matter, through new modes of combining the same elements; and doubtless our admiration would increase, should we mount along the entire functions of assimilation, and find, at each step of the ascending series, that the whole agency has been committed to forces that have no existence in the inorganic world; that the whole is the harmonious result of a principle which may form an intermediate link between spirit and matter; and that there is no power within our control

by which we can determine the nature of the changes. Casting a glance at the vegetable world, we find the connection continued, by other analogous links, with elementary matter itself; but here, as in the higher department of nature, the line of separation is equally defined, however low in the scale of analogy may be the properties of life which have their beginning in vegetable organization.

It is here, then, at the threshold of life, as in the propagation of the species, that we especially witness a substitution for Creative Power; and as all that appertains exclusively to the organic world was perfectly distinct in its Creation from the inorganic, so are the substituted processes of generation, and of the conversion of dead into living matter, equally distinct from the causes and results of inorganic processes.

However, also, we may scrutinize the process of digestion in either of the organic kingdoms, we find that nature has provided intricate means for the purpose, and established analogies in their organization as well as their phenomena, that are unknown in the inorganic world. And if we carry the analysis through the whole labyrinth of animal and vegetable creation, we meet, at every step, with so much Unity of Design, such gradual modifications of structure and functions, and all conspiring to a specific end, we must conclude that the whole, are governed by forces peculiar to themselves.

But, notwithstanding the astonishing Unity of Design, and the gradation of analogies which connect together the most dissimilar of the systems which are designed for digestion, there are peculiarities attending each in every species of animals, which place at a remote distance the laws of chemistry. "An alimentary canal is observed in every class of animals, and almost in every species, but its form and structure vary according to the situation of animals in the scale, or according to the kind of food on which they are destined to subsist, and the extent of the elaboration it requires to undergo. The peculiarities presented by the digestive organs are, therefore, intimately connected with the diversities of form manifested by the organs of animal life, and with all the living habits and instincts of animals." We see, also, an extension of this principle in relation to certain periods of life. In ruminating animals, for instance, the fourth stomach is alone employed during dentition. And yet, with all this variety, there is but one common result, one homogeneous chyle. The same principles, the same vital impulses which ultimately develope and call into action the three first stomachs of the ruminantia, appear to be not less concerned in the consummation of their final cause.

One of the most important arguments in favor of vital digestion consists in the remarkable *endowments* of the stomach, as manifested by its vital signs, and by the sympathies which prevail between this organ and all other parts. The final cause of this peculiar constitution of the stomach, this lavish supply of the properties of life, this subservience of other organs to its dominion, must be sought in its adaptation to the generation of a fluid that may bestow the first and most difficult act of vitalization upon dead matter. There would also have been something harsh and abrupt in nature, to have admitted into the recesses of her living organization mere dead matter. It is opposed to all analogy, and is, therefore, opposed to all reason. But, that a fluid should

perform this astonishing office, this first and great step in the ascending series, it must possess in a high degree the principle of life. Mysterious as it may be represented, we must all of us come at last to the admission of the existence of a vital principle; yet far less mysterious, and far less difficult of comprehension than the human soul. It is fair, then, to conclude that an organ destined for such a high function should possess that principle, in common with all other parts, as the means on which its function depends; and the best evidences in favor of this analogical inference are to be seen in its diversified manifestations of life. To deny the dependence of vital results upon specific powers, necessarily involves an exclusion of all the evidence by which we infer the existence of gravitation, or of the intangible properties of matter.—As well may we doubt the reality of spirit, “or the Maker of the eye, because it cannot see Him that made it.”

We have seen, also, that it is conceded by philosophers who defend, *in extenso*, the chemical hypothesis of life, that there may be *something* appertaining to the stomach totally distinct from the chemical powers, and which is capable of imbuing the chyme with *vitality* and an *organic* condition; and it is, therefore, quite a philosophical conclusion, that this *vital something* has an important agency in preparing the material for the admitted exercise upon it of the vivifying or organizing power. Nor can there be any valid objection to the supposition that this vitalizing power, which so far transcends the chemical forces in the organizing effect it is allowed to exert, may be fully adequate to any transmutations the food may undergo; and this inference is the more corroborated by the consideration that matter already in an organic state must be better fitted for the process of vivification, than it can possibly be after its elements are broken up and recombined by forces with which those of life are in absolute opposition. Besides, the vitality of the gastric juice, or the vital influence of the stomach itself, being fully admitted, and even capable of organizing the food anew, this, in itself, should protect the alimentary matter against any chemical agencies which have been supposed to operate. That this counteracting power, indeed, prevails to the full extent which I have alleged, appears to be rendered certain by the ordinary absence of any of those chemical changes which take place where numerous substances are mixed together out of the stomach,—substances which often possess strong chemical affinities for each other, and whose operation within the stomach would be promoted by its high temperature. On the contrary, whatever the variety, it is uniformly resolved into one and the same homogeneous substance, utterly unlike the results of chemical reactions of one kind of food upon other kinds; and what is also as conclusive as it is astonishing, the chyle is apparently the same substance in all animals. Chemistry must here be consistent with itself, and not renounce, for the sake of hypothesis, those precise laws by which, in its legitimate pursuit, it lays open, with astonishing exactness, what had appeared the arcana of nature. Here, too, upon the chemico-physiological hypothesis, is presented an instance in which it must be necessarily assumed that the properties of life and the forces of chemistry must act together in concert in converting dead into living matter,—one destroying, and at the same moment the other vitalizing; whilst

the assumption is contradicted by all that is known of the relation of these forces to each other.

It will be also readily conceded that it is the demand of philosophy not to multiply causes, where one is perfectly adequate; and especially where it is admitted that all the others are of themselves wholly inadequate.

This remark may be also equally applied to a common assumption which is set forth in the following apparently plausible manner. "The vitalists," says one of their opponents, "are loth to admit the operation of chemical agents at all, and would seem to consider it derogatory to suppose that any changes, save the subtle ones effected by the powers of life, are worked upon the aliment." "The *vital principle*," he says, "whatever it may be, incessantly makes use of chemical and mechanical agents for its purposes; and it is no more degrading to it to employ an acid liquid, and a trituration process, in order to digest the aliment, than it was to have recourse to bony levers, cartilaginous pulleys, and tendonous ropes."

Here, in the first place, you will observe an entire begging of the question as to digestion by an acid, since that has never been shown, and is the main point at issue. It is a perfectly unfounded and extorted inference from the factitious analogy supposed to be seen in the admitted mechanical movement of the food in the stomach, bony levers, cartilaginous pulleys, &c. But the pretended analogy, I say, is utterly inapplicable, were it admissible to reason from better premises of this nature to the existence of important facts which have no other foundation. The bony levers, muscles, tendons, heart, and large blood-vessels, are mere instruments acted upon by the vital principle, and have no part in the vital results, except as they are the passive instruments of the properties of life. You will observe the same distinction between the process of digestion, and the mechanical movement of the food in the stomach, or the "trituration" of the food, as it is erroneously called by the writer just quoted; since food is not triturated by the stomach excepting where that organ is designed to supply the place of teeth. You will observe, I say, the total want of analogy between that mechanical movement of the food, and the assumed action of an acid; since, in the latter case, a radical change is supposed to be wrought in the alimentary mass, whilst no such change is wrought by the mere movement, or even by the trituration or grinding of food in the stomach. The contractions of the stomach, which are purely of a vital nature, facilitate the process of digestion; but they do no more than to expose the food freely to the action of the gastric juice, by which, alone, the conversion into chyme is performed. The contractions, or "trituration," are exactly on a par, as auxiliaries to digestion, with the teeth, or with the knife, which divide the food. The *acid* alone applies to the supposed chemical process of chymification. This is the only agent, involving the only force distinct from the vital principle that is supposed to operate, and to take part with the properties of life in the functions which belong to those properties. Nor is this all. Those chemical forces, or an equivalent agent, are supposed to appertain to the gastric juice, (a product of the most highly endowed organ in the animal system); and through that product, and by that product, to operate inde-

pendently of the vital properties, or, under their control. But, here it may be again affirmed that throughout nature there is not an analogous fact to warrant the conclusion; and with equal truth it may be said that there is nothing to aid our conception of the *co-operation* of the chemical and vital forces, whilst all that is known of their relations to each other proclaims their absolute independence.

But, again, it is the admitted final cause of the gastric juice to bestow life upon dead matter, whilst it is incontrovertible that inorganic matter is insusceptible of any such influence from gastric action.—Every fact proclaims that nature has provided the *vegetable kingdom* for the purpose, especially, of determining organic combinations out of inorganic substances for the sustenance of animal life. In the language of Liebig, “The first substance capable of affording nutriment to animals is the LAST product of the CREATIVE ENERGY,”—ay, “the CREATIVE ENERGY,” he says, “of vegetables.”—(Animal Chemistry.) It is manifest, therefore, that it would be an absurdity on the part of nature to have ordained that chemical agencies should operate even at the very threshold of life, at the very fountain for which she had provided elaborate means to subvert the combinations of chemistry, and to bring them into those entirely new arrangements that approximate the changes they are destined to undergo in the animal stomach. And far less probable is it, that this fundamental principle should be lost as we ascend from vegetable to animal organization; since every chemical result within the stomach would tend to reduce the aliment to the state of that inorganic matter whose complete reduction into organic compounds was effected by the vegetable kingdom for the uses of the animal. Such chemical results, therefore, would counteract the great final cause of nature, in either organic kingdom; and, in the animal, would render the means of sustenance more and more indigestible, and progressively liable to the condition of inorganic matter. This is fully allowed by the chief of the school of pure chemistry; as shown in the foregoing parallel quotations.

But again I say, if the vital principle be “capable of making use of chemical agents,” no reason can be assigned why it may not be equal to the whole work of digestion, and of every other process of living beings. The *simple* construction may be comprehended, whilst the other is utterly unintelligible. The former alone is agreeable to the rules of philosophy, and abolishes the inextricable confusion which attends the chemical hypothesis. What, indeed, can be meant, by the vital properties making use of chemical forces? Can there be a more glaring absurdity? more absolute nonsense? How are those chemical forces brought into use, how held in subjection, how for ever maintained in one exact operation in each particular organic process, of which there are multitudes, distinct from each other, going on in the same individual? How do they elaborate from one common, homogeneous fluid, either the blood, or the sap, all the various, unique, unchanging, secreted products of the whole organic being? Products, for ever the same in every part, yet differing from each other according to the nature of the part? Did you ever hear or dream of any thing analogous to this in that inorganic world where chemistry holds its empire?—When do those chemical forces begin to operate, in the living body,

what part do they perform, and what is the allotment of the properties of life? Is there any *known* concert of action between the two species of forces? On the contrary, is it not every where demonstrated that the properties of life are in direct opposition to the forces of chemistry?

Whatever be the construction, by uniting the two forces, (as is done by the only chemical school that is entitled to a respectful notice,) we convert what is a simple problem, like all other processes of nature, into the greatest paradox that has been yet devised by the ingenuity of man. It is in vain to say that some one or two of the products of organization, such as carbonic acid, and urea, are such as result from chemical affinities, since these are excrementitious; whilst chemistry assures us that all organic compounds are utterly different in their elementary combinations from any compound of a chemical nature.

Thus might I go on to argue this subject upon general principles alone; whilst at every step of the argument, we should see the whole chemical hypothesis of life taking its proper rank as a dream of the imagination, or as a project of ambitious minds.

But, I must hasten to the specific facts which are brought by the chemical and the chemico-physiological schools to the support of their preconceived hypotheses; for you must understand that digestion was regarded as a chemical process, and according even to its present interpretation, whilst chemistry was yet in its infancy.

Digestion having been assumed to be more or less, or altogether, a chemical affair, it rationally followed that it might be imitated by art. Accordingly, when this ambitious science had succeeded in turning the whole inorganic world into the laboratory, it set itself at the manufacture of organic compounds, and even at the entire animal. It did not, like Alexander, sit down and weep because it had no more worlds to conquer; but, like Shakspeare, having "exhausted worlds, it then imagined new." Even eminent physiologists, who should look with jealousy upon any invasions upon the laws of nature, especially upon such as it is their peculiar province to illustrate, began the manufacture of gastric juice by fire and acids, and metallic salts. We are thus presented by these philosophers with artificial compounds, of a most incongruous nature, and we are told that each one is the gastric juice; that each is capable of the same precise results as that universal product of animals, apparently the same in all, and elaborated from the blood by an organ of the highest vital endowments, and to which there is nothing analogous in all the other products of living beings, each product being, also, equally unique, and all derived from one common source.

A diversity of opinions exists as to the real nature of the chemical agent supposed to be employed by nature in the process of digestion. Free muriatic acid having been found, or supposed to exist, in the stomach, it has been concluded by many that this must be the great agent; whilst Dr. Prout, and others, affirm that "free muriatic acid more or less retards the process of reduction." Dr. R. Thompson, however, states that, by digesting muscular fibre in dilute muriatic acid, he produced a substance "exactly resembling chyme." This experiment was pretty widely repeated, and many were equally successful with "dilute muriatic acid" as was Dr. Thompson. Others, on the contra-

ry, declared their failure, and others, like Dr. Prout, maintained that this acid retarded digestion. Eberle had already advanced the hypothesis that mucous membranes, no matter whether of the stomach or the bladder, dissolved either in muriatic or acetic acid, would form the true gastric juice, and perform its wonderful operations. There is now a general bias in favor of one of these compounds, though other preparations are supposed by many to form very good gastric juice. Again, it is said that the "digestive mixture," as it has been well denominated by the manufacturers, "retains its solvent properties for months," whilst the gastric juice loses its solvent power soon after its abstraction from the stomach. And what equally establishes a total difference between the "mixture" and the gastric juice is the no small circumstance that the chemist may torture and extinguish the artificial "digestive principle" in a variety of ways, and then transmute it back in all its vigor. Thus, according to Schwann and Müller, the artificial "digestive principle" may be neutralized by an alkali, and afterwards "precipitated from its neutral solution by *acetate of lead*, and obtained again in an active state from that precipitate by means of hydro-sulphuric acid." This precipitate, we are told, when thus treated, and thus compounded of principles radically different from the original mixture, is essentially the same as the gastric juice, and that the results of such artificial preparations must be taken as the test of the *physiology* of natural digestion; that, abandoning nature, we must look to the resources of the laboratory for any satisfactory account of her vital processes. Nor do I at all exaggerate; for it is distinctly avowed that we knew nothing of digestion till the invention of the artificial mixtures. Thus, it is said of Schwann by one so able and distinguished as Müller, that he, (Schwann) "having discovered that the infusion of dry mucous membrane with dilute acid, even after it is filtered, still retains its digestive power, the digestive principle, *therefore*, is clearly in solution, and *the theory of digestion by contact falls to the ground.*" Here, a most important physiological induction is wholly founded upon a process which has not the most remote connection with organized matter; and as to the paradox which involves the combined agencies of muriatic acid, alkalies, acetate of lead, hydro-sulphuric acid, and mucous membranes, it is certainly a burlesque upon the science of chemistry.

I have said that the experimenters took the hint of manufacturing gastric juice from the occasional discovery of an acid in the stomach. But, this is undoubtedly a rare phenomenon in a healthy stomach, and where the food has been at all appropriate in quality and quantity.—The chemical hypothesis, as I have said, was long ago in vogue, and was put at rest by demonstrative proof. Distinguished observers, Hunter, Haller, Willis, Spallanzani, Fordyce, and more recently Dumas, Schultz, and others, insist that the reputed acid is the result of a true chemical decomposition of vegetable matter. Spallanzani, whose experiments were almost endless, Scopoli, Chevreuil, and others, rarely succeeded in finding it at all, and in some animals never. Spallanzani, indeed, affirms that the gastric juice is neither acid nor alkaline in its natural state.

As far back as Haller's day, when this subject was agitated, it is said by this illustrious and accurate observer, that, "although there

may be some rare signs of an acid in the stomach, it does not, therefore, become us to suppose that food is animalized by a chemical process; much less to compare this process with the action of an acid." And, anticipating the modern experiments with the "digestive mixture," he declares of analogous proceedings at his own era, "frustra etiam quisquam, imitatus liquores acres chemicos, liquorem corrodentem invenerit, qui carnem in pulvem resolvat."—"There are some," he says, "who, by means of acrid chemical liquors, have vainly invented a corroding fluid, which reduces flesh into a pultaceous substance, but which is no imitation of chyme." And there can be no doubt that Hunter's prophecy holds good to this day, that—

"If ever any matter is formed in any of the juices secreted in any part of a vegetable or animal body similar to what arises from fermentation, we may depend on it, it arose from that process; but we may also depend on it, that there is a defect of the living principle in these cases."

These are not the mere speculations of genius, but the facts and the conclusions of genius after a long, and wide, and experimental survey of nature. And are these observations, nay, our own experience, our own senses, to be set aside to accommodate a hypothesis of life which identifies dead, even inorganic, with living beings?

I have yet a few words more, in respect to the artificial product which results from the "digestive mixture," and which is said to be identical with the chyme of the human and other stomachs. In the first place, this assumed fact has never been shown in the slightest degree; and that it is the merest assumption is not only proved by what I have already set forth, but is fully admitted by those who advocate the chemical doctrine. The conclusion rests upon the mere appearance which the artificial substance offers to the eye. Thus, it is lately said by Dr. Davy, that,—

"It is impossible to witness the change which takes place in muscular fibre, in consequence of *putrefaction* giving rise to a fluid very like chyme in *appearance*, without asking, may not putrefaction be concerned in digestion itself, according to the earliest theoretical notions on the subject;" and as now maintained by Liebig, and his followers.

Farther on, however, in the same work, he says, "twenty different semi-fluids might be mentioned, to which, as far as the eye can judge, this putrid matter bears as close a resemblance as to *chyme*."

I might thus go on to multiply proofs of the foregoing nature, not a little of which is supplied by distinguished observers of the present day; and a variety of other facts might be brought in opposition to the chemical hypothesis of digestion. But time presses, and I must come to a conclusion; but not without expressing the conviction that it is here, especially, that the physiologist must raise his principal defence against the invasions of chemistry. Defeated upon this ground; the adversary may be easily expelled from the whole domain of organic life.

* * * PAINE'S *Medical and Physiological Commentaries*, in 3 volumes, may be had *only* at the Author's residence, in the City of New York. No. of royal octavo pages 1988. Price of the 1st and 2d volumes, \$6.00. The 3d volume without charge.

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